REMARKS

Reconsideration and allowance of the present application based on the following remarks are respectfully requested. Claims 1, 6 and 15 have been amended solely to correct minor clerical errors and not for limiting the scope of these claims. Claims 17-20 have been added. Claims 17-20 depend from either claim 14 or claim 15.

Applicants note that the Examiner checked box 10 on form PTO-326 and states that "The drawings filed on January 12, 2001 are objected to by the Examiner." Applicants, however, did not find any reasons for such objection to the drawings in the body of the Office Action. Therefore, Applicants understanding is that the drawings are accepted by the Examiner.

Priority

The Examiner states that the copy of the priority application filed in Europe on January 14, 2000 provided by Applicant is not certified by the corresponding authority as required by 35 U.S.C. 119(b). Applicants respectfully disagree. Applicants submitted a certified copy of European Patent Application 00300246.6 filed in Europe with the filing papers of the present application on January 12, 2001 pursuant to 35 U.S.C. § 119(b). A copy of the European Patent Office Certificate is enclosed for the records.

Preliminary Amendment

The Examiner states that the Preliminary Amendment filed April 16, 2001 has been entered-in-part because the insertions were made at wrong line-numbers and the amendment to the original wordings were not entered because the wordings were not found at the indicated pages. Therefore, Applicants have amended the specification and made the appropriate corrections. Applicants note, however, that the April 16, 2001 date noted in the Office Action is in error. The Preliminary Amendment was filed January 12, 2001.

Claim Rejection – 35 USC § 102

Claims 1-3 and 13 are rejected under 35 U.S.C. § 102(b) as being allegedly anticipated by Nishi (US Pat. No. 5,003,342). Applicants respectfully traverse this rejection for at least the following reasons.

With respect to claim 1, the Office Action contends that Nishi discloses a lithographic projection apparatus comprising all the elements recited in claim 1 and specifically a calibration system around element 12 shown in Fig. 1 or element 13 shown in Fig. 3, which is an interferometer system to measure lateral displacement of a reference point in a plane of the object table 9 as a function of tilt, at the measurement position, as recited in col. 4, lines 61-68 and col. 8, lines 10-30, wherein the calibration system around element 12 in Fig. 1 or element 13 in Fig. 3 comprises: a diffraction grating 15 mounted to the second object table 9 as shown in Fig. 1 and Fig. 3 and recited in col. 5, lines 40-50; an illuminator to the left of light guide 21 which generates a measurement beam of radiation and directs the beam through a reflector 22-23 to be incident on diffraction grating 15 and a detector which detects the position of diffraction grating 15. Applicants respectfully disagree.

Claim 1 recites, *inter-alia*, "a calibration system to measure lateral displacements of a reference point in a plane of said second object table as a function of tilt, at said measurement position, wherein said calibration system comprises: a diffraction grating mounted to said second object table; an illuminator which generates a measurement beam of radiation and directs it to be incident on said diffraction grating so as to be diffracted thereby; and a detector which detects the position of said diffraction grating." By using a calibration system for measuring lateral displacements of a reference point in a plane of the second object table as a function of tilt, it is possible to measure the Abbe arm at the measurement position and to calibrate the Abbe arm to a predetermined vertical distance from the reference plane of the second object table.

Therefore, in the invention recited in claim 1, the calibration system is provided to measure lateral displacements of a reference point in a plane of said second object table as a function of tilt, at the measurement position. In contrast, Nishi merely provides a measurement system in which the position of the wafer stage 9 in the X and Y directions is measured. In col. 8, lines 10-30, Nishi teaches that the inclination of the wafer stage may vary by a slight angle during each stepping operation due to a manufacturing error in the movable mirror Mx or My, or the yawing of the wafer 9, i.e. rotation of the wafer about vertical axis Z. Applicants submit that Nishi is merely concerned about displacement errors due to rotation about the Z axis and not tilting of the XY plane. Therefore, Nishi is completely silent about providing a calibration system to measure lateral displacement as a function of tilt. Consequently, for at least the above reasons, Nishi does not disclose, teach or suggest the subject matter recited in claim 1.

Therefore, Applicants respectfully submit that claim 1 is patentable and respectfully request that the rejection under § 102(b) of claim 1 be withdrawn.

With regard to claim 2, the Office Action contends that Nishi's grating 15 is transmissive and Nishi's calibration system around element 12 in Fig. 1 or element 13 in Fig. 3 further comprises a light guide 21 which directs the measurement beam to be incident on the diffraction grating 15 in a direction substantially independent of the tilt of the second object table as is inherent or implicated in col. 6, lines 23-35 with the system 21-22-23 detached from table 9.

Claim 2 is dependent from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claim 2 is patentable and respectfully request that the rejection under § 102(b) of claim 2 be withdrawn.

Moreover, Nishi does not disclose, teach or suggest the additional limitations of claim 2. Specifically, Nishi does not disclose, teach or suggest a light beam which directs the measurement beam to be incident on the diffraction grating in a direction substantially independent of the tilt of the object table. In col. 6, lines 23-35, Nishi is merely concerned about detecting the X, Y direction positions of a chip by irradiating an alignment mark on the wafer W by detecting light diffracted from beam spot SPx or SPy.

With regard to claim 3, the Office Action contends that Nishi's calibration system around element 12 or element 13 is constructed and arranged to measure displacements of a reference point in the reference plane 9, as is inherent and conventional for an interferometer system, and the grating 15 is mounted parallel to the reference plane of the object table 9 (col. 5, lines 40-45).

Claim 3 is dependent from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claim 3 is patentable and respectfully request that the rejection under § 102(b) of claim 3 be withdrawn.

With regard to claim 13, the Office Action contends that Nishi's calibration system comprises a plurality of calibrations systems, one around element 12 or element 13, another around element 18, for measuring displacement of the second object table 9 with tilt as expressly recited in col. 8, lines 10-14, about a plurality of axes (X and Y.)

Claim 13 is dependent from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claim 13 is patentable and respectfully request that the rejection under § 102(b) of claim 13 be withdrawn.

Moreover, Nishi does not disclose, teach or suggest the additional limitations of claim 13. Specifically, Nishi does not disclose, teach or suggest a plurality of calibration systems for measuring displacement of the second object table with tilt about a plurality of axes. As stated above, Nishi is merely concerned about detecting yawing of the wafer 9, i.e. rotation of the wafer about vertical axis Z, not tilt of the XY plane.

Claims 4-12 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Nishi. Applicants respectfully traverse this rejection for at least the following reasons.

The Office Action contends that Nishi recites all the limitations of claim 4, as applied to claim 2. The Office Action concedes that Nishi does not recite that the light guide system 21-22-23 comprises a plurality of reflectors and is positioned to reflect the measurement beam onto a return path parallel to the incident path and passing through the diffraction grating in a direction opposite to the incident path. The Office Action, however, contends that a plurality of reflectors, being a mere design choice, is within skill in the art and thus it would have been obvious to design a light guide system comprising a plurality of reflectors. Applicants respectfully disagree.

Claim 4 is dependent indirectly from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claim 4 is patentable and respectfully request that the rejection under § 103(a) of claim 4 be withdrawn.

Moreover, Applicants submit that the light guide recited in claim 4 comprises a plurality of reflectors mounted to the second object table behind the diffraction grating relative to the illuminator and thus the design of the light guide of claim 4 is completely different from Nishi's light guide system design and thus there is no motivation for one of skill in the art to modify Nishi's light guide system to include, for example, a plurality of reflectors.

Claims 5-8 are dependent indirectly from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claims 5-8 are patentable and respectfully request that the rejection under § 103(a) of claims 5-8 be withdrawn.

With regard to claim 9, the Office Action contends that the limitation that the plane reflector of claim 7 is positioned so as to reflect only the zeroth order of diffraction is a mere matter of design choice aimed at optimizing the performance of a tilt measuring system. The Office Action also contends that the recitation "zeroth order of diffraction" is misleading. Applicants respectfully disagree.

Claim 9 is dependent indirectly from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claim 9 is patentable and respectfully request that the rejection under § 103(a) of claim 9 be withdrawn.

Moreover, Applicants submit that reflecting only the zeroth order of diffraction is not disclosed or suggested in Nishi and there is no motivation in the prior art to provide the claimed apparatus with a plane reflector sized and positioned so as to reflect substantially only the zeroth diffraction order of the measurement beam diffracted by the diffraction grating. With regard to the phrase "zeroth order of diffraction," Applicants submit that this phrase does not refer to the incident beam and one of ordinary skill in the art would clearly understand "to reflect substantially only the zeroth diffraction order of the measurement beam..."

With regard to claims 10-12, claims 10-12 are dependent indirectly from claim 1. Therefore, for at least the above reasons, Applicants respectfully submit that claims 10-12 are patentable and respectfully request that the rejection under § 103(a) of claims 10-12 be withdrawn.

Claims 14 and 15 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Nishi as applied to claim 1 and further in view of Ota (US Pat. No. 5,831,739), Murata (JP-09199573 A) and Yamamoto *et al.* (US Pat. No. 5, 053,628). Applicants respectfully traverse this rejection for at least the following reasons.

With regard to claim 14, the Office Action contends that Nishi describes a method of calibrating a lithographic projection apparatus including measuring a position of a reference point on a surface of an object table 9 for holding a substrate W having a surface to be exposed wherein the limitation of different tilts is a further generalization or expansion within skill in the art of Nishi's recitation in col. 8, lines 10-14. The Office Action further contends that Nishi's method is "capable of performing everything that is claimed by Applicant." The Office Action also contends that the limitations covered by Nishi's method are separately, specifically and additionally rendered obvious by Murata and thus it would have been obvious to one of ordinary skill in the art to eliminate from Nishi's invention those elements that are not needed while retaining only the essential steps to practice Applicant's invention as recited in Murata, Ota and Yamamoto *et al.* Applicants respectfully disagree.

As stated previously, Nishi merely provides a measurement system in which the position of the wafer stage 9 in the X and Y directions is measured. In col. 8, lines 10-30,

Nishi teaches that the inclination of the wafer stage may vary by a slight angle during each stepping operation due to a manufacturing error in the movable mirror Mx or My, or the yawing of the wafer 9, i.e. rotation of the wafer about vertical axis Z. Applicants submit that Nishi is merely concerned about displacement errors due to rotation about the Z axis and not tilting of the XY plane. Therefore, Nishi is completely silent about measuring a position of a reference point on a surface of an object table for holding a substrate having a surface to be exposed at different tilts.

With regard to Murata, this reference appears merely to teach a laser beam for measurement of positions of the wafer in X and Y direction. The laser beam is partly separated as a monitor beam and guided to a position sensor 9b to measure displacement of the monitor beam and to calculate an Abbe error based on the displacement and the tilt angle of stage 11. Murata is, however, completely silent about measuring a position of a reference point on a surface of an object table at different tilts. Moreover, Murata does not disclose or suggest calculating a distance between the surface of the object table and a rotation-invariant point of the object table. In fact, Murata is simply concerned about measuring the rotation of stage 11 and element 8a associated to stage 11 via displacement of a light beam on sensor 9b (see, Figure 2 of Murata).

With regard to Ota, this reference merely teaches an alignment method in which a plurality of alignment marks are used in X and Y coordinates. As described in col. 8 lines 14-20 and shown in Figure 5 of Ota, the wafer mark MXi for the X-axis is a grating-shaped pattern comprising small square patterns which are arrayed at a predetermined pitch in the direction Y and the wafer mark MYi for the Y-axis is a grating-shaped pattern comprising small square patterns which are arrayed at a predetermined pitch in the direction X. However, Ota does not disclose or suggest measuring a position of a reference point on a surface of an object table at different tilts. Ota is related to solving a different problem than the invention recited in claim 14.

With regard to Yamamoto *et al.*, this reference merely teaches an apparatus for wafer position alignment using interference fringes reflected by a diffraction grating on the wafer. The interference fringes are reflected back through the projection lens system and detected by a phase meter. Yamamoto *et al.* however, does not disclose or suggest anything relating to measuring a position of a reference point on a surface of an object table at different tilts.

Moreover, even if combining the above relied upon references, one of skill in the art would not arrive at the method of calibrating a lithographic apparatus recited in claim 14.

Therefore, none of the relied upon references, i.e. Nishi, Murata, Ota and Yamamoto *et al.*, alone or in combination, discloses, teaches or suggests the subject matter recited in claim 14.

With regard to claim 15, the Office Action contends that Nishi describes a method of manufacturing a device using a lithographic projection apparatus including detecting displacements of a reference point of the second object table at various angles of tilt when situated at the measurement position as is inherent in Nishi and further rendered obvious by Murata, Ota and Yamamoto *et al.* as applied to claim 14. Applicants respectfully disagree.

As stated above, Nishi is merely concerned about displacement errors due to rotation about the Z axis and not tilting of the XY plane. Moreover, contrary to the Office Action's contention, Nishi is completely silent about detecting displacements of a reference point of the second object table at various angles of tilt.

As stated above, Murata appears merely to teach a laser beam for measurement of positions of the wafer in X and Y direction. Murata is, however, silent about detecting displacements of a reference point of the second object table at various angles of tilt when situated at a measurement position.

As stated above, Ota merely teaches an alignment method in which a plurality of alignment marks are used in X and Y coordinates. Ota is, however, completely silent about tilting of the object table much less detecting displacements of a reference point of the second object table at various angles of tilt. Similarly, Yamamoto *et al.* merely describes an apparatus for wafer position alignment using interference fringes reflected by a diffraction grating on the wafer. The interference fringes of Yamamoto *et al.* are reflected back through the projection lens system and detected by a phase meter. Yamamoto *et al.*, however, is completely silent about detecting displacements of a reference point of the second object table at various angles of tilt.

Moreover, even if combining the above relied upon references, one of skill in the art would not arrive at the method of manufacturing a device using a lithographic projection apparatus as recited in claim 15.

Consequently, none of the relied upon references, i.e. Nishi, Murata, Ota and Yamamoto *et al.*, alone or in combination, discloses, teaches or suggests the subject matter recited in claim 15.

Therefore, for at least the above reasons, Applicants respectfully submit that claims 14 and 15, and claim 16 which is directly dependent from claim 15 are patentable and respectfully request that the rejection under § 103(a) of claims 14-16 be withdrawn.

New claims 17-20 have been added. Claims 17-20 depend from either claim 14 or claim 15. Applicants submit that claims 17-20 are patentable for at least the reasons presented above for claim 14 and claim 15.

CONCLUSION

In view of the foregoing, the claims are now believed to be in form for allowance, and such action is hereby solicited. If any point remains in issue which the Examiner feels may be best resolved through a personal or telephone interview, please contact the undersigned at the telephone number listed below.

Attached is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned **"Version with markings to show changes made"**.

All objections and rejections having been addressed, it is respectfully submitted that the present application is in a condition for allowance and a Notice to that effect is earnestly solicited.

Respectfully submitted,

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Enclosures: Appendix

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

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The specification has been changed as follows:

Page 2, delete the whole paragraph starting in line 25 and replace it with the following new paragraph:

-- Lithographic projection apparatus can be used, for example, in the manufacture of integrated circuits (ICs). In such a case, the patterning means may generate a circuit pattern corresponding to an individual layer of the IC, and this pattern can be imaged onto a target portion (comprising one or more dies) on a substrate (silicon wafer) that has been coated with a layer of radiation-sensitive material (resist). In general, a single wafer will contain a whole network of adjacent target portions that are successively irradiated via the projection system, one at a time. In current apparatus, employing patterning by a mask on a mask table, a distinction can be made between two different types of machine. In one type of lithographic projection apparatus, each target portion is irradiated by exposing the entire mask pattern onto the target portion [in one go] <u>at once</u>; such an apparatus is commonly referred to as a wafer stepper. In an alternative apparatus – commonly referred to as a step-and-scan apparatus – each target portion is irradiated by progressively scanning the mask pattern under the projection beam in a given reference direction (the "scanning" direction) while synchronously scanning the substrate table parallel or anti-parallel to this direction; since, in general, the projection system will have a magnification factor M (generally <1), the speed V at which the substrate table is scanned will be a factor M times that at which the mask table is scanned. More information with regard to lithographic devices as here described can be gleaned, for example, from US 6,046,792, incorporated herein by reference. --

Page 5, before line 1, insert:

--SUMMARY OF THE INVENTION--

Page 8, line 8, insert:

--BRIEF DESCRIPTION OF THE DRAWINGS--

Page 8, line 24, insert:

--DETAILED DESCRIPTION OF THE INVENTION--

Page 9, delete the whole paragraph starting in line 12 and replace it with the following new paragraph:

-- The beam PB subsequently intercepts the mask MA which is held in a mask holder on a mask table MT. Having passed through the mask MA, the beam PB passes through the lens PL, which focuses the beam PB onto a target area C of the substrate W. With the aid of the interferometric displacement measuring means IF, the substrate table WT can be moved accurately, e.g. so as to position different target areas C in the path of the beam PB. Similarly, the first positioning means can be used to accurately position the mask MA with respect to the path of the beam PB, e.g. after mechanical retrieval of the mask MA from a mask library. In general, movement of the object tables MT, WT will be realized with the aid of a long stroke module ([course] <u>coarse</u> positioning) and a short stroke module (fine positioning), which are not explicitly depicted in Figure 1. --

Page 9, delete the whole paragraph starting in line 22 and replace it with the following new paragraph:

-- The depicted apparatus can be used in two different modes:

1. In step mode, the mask table MT is kept essentially stationary, and an entire mask image is projected [in one go] <u>at once</u> (i.e. a single "flash") onto a target area C. The substrate WT is then shifted in the x and/or y directions so that a different target area C can be irradiated by the beam PB; --

Page 14, delete the whole paragraph starting in line 28 and replace it with the following new paragraph:

-- [Whilst] While we have described above a specific embodiment of the invention it will be appreciated that the invention may be practiced otherwise than described. The description is not intended to limit the invention. --

Claims 1, 6 and 15 have been amended as follows:

1. (Twice Amended) A lithographic projection apparatus comprising:

an illumination system [for supplying] to supply a projection beam of radiation;

a first object table [for holding] to hold a projection beam patterning structure capable of patterning the projection beam according to a desired pattern;

a second object table [for holding] to hold a substrate having a surface to be exposed, such that, when held on the table, the said surface lies in a reference plane;

a projection system which images the patterned beam onto a target portion of the substrate; [and]

a positioning system which moves said second object table between an exposure position, at which said projection system can image said patterned beam onto said substrate, and a measurement position; and

a calibration system to measure lateral displacements of a reference point in a plane of said second object table as a function of tilt, at said measurement position, wherein said calibration system comprises:

a diffraction grating mounted to said second object table;

an illuminator which generates a measurement beam of radiation and directs it to be incident on said diffraction grating so as to be diffracted thereby; and

a detector which detects the position of said diffraction grating.

6. (Twice Amended) Apparatus according to claim 1, wherein said illuminator is arranged to emit said measurement beam along an incident path substantially perpendicular to said diffraction grating and passing therethrough, and [said] comprising a light guide [comprises] including a retro-reflector mounted to said second object table behind said diffraction grating relative to said illuminator to reflect said measurement beam along a return path substantially parallel to said incident path and passing back through said diffraction grating.

15. (Twice Amended) A method of manufacturing a device using a lithographic projection apparatus comprising:

providing a substrate provided with a radiation-sensitive layer and having target portions thereof to an object table;

providing a projection beam of radiation using an illumination system;

using a projection beam patterning structure to endow the projection beam with a pattern in its cross section;

moving the object table to an exposure position;

projecting the patterned beam of radiation onto said target portions of the substrate; and

detecting displacements of a reference point of said [second] object table at various angles of tilt when situated at [said] a measurement position.

End of Appendix